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Tactical Dam Analysis Model (TACDAM) User's Manual

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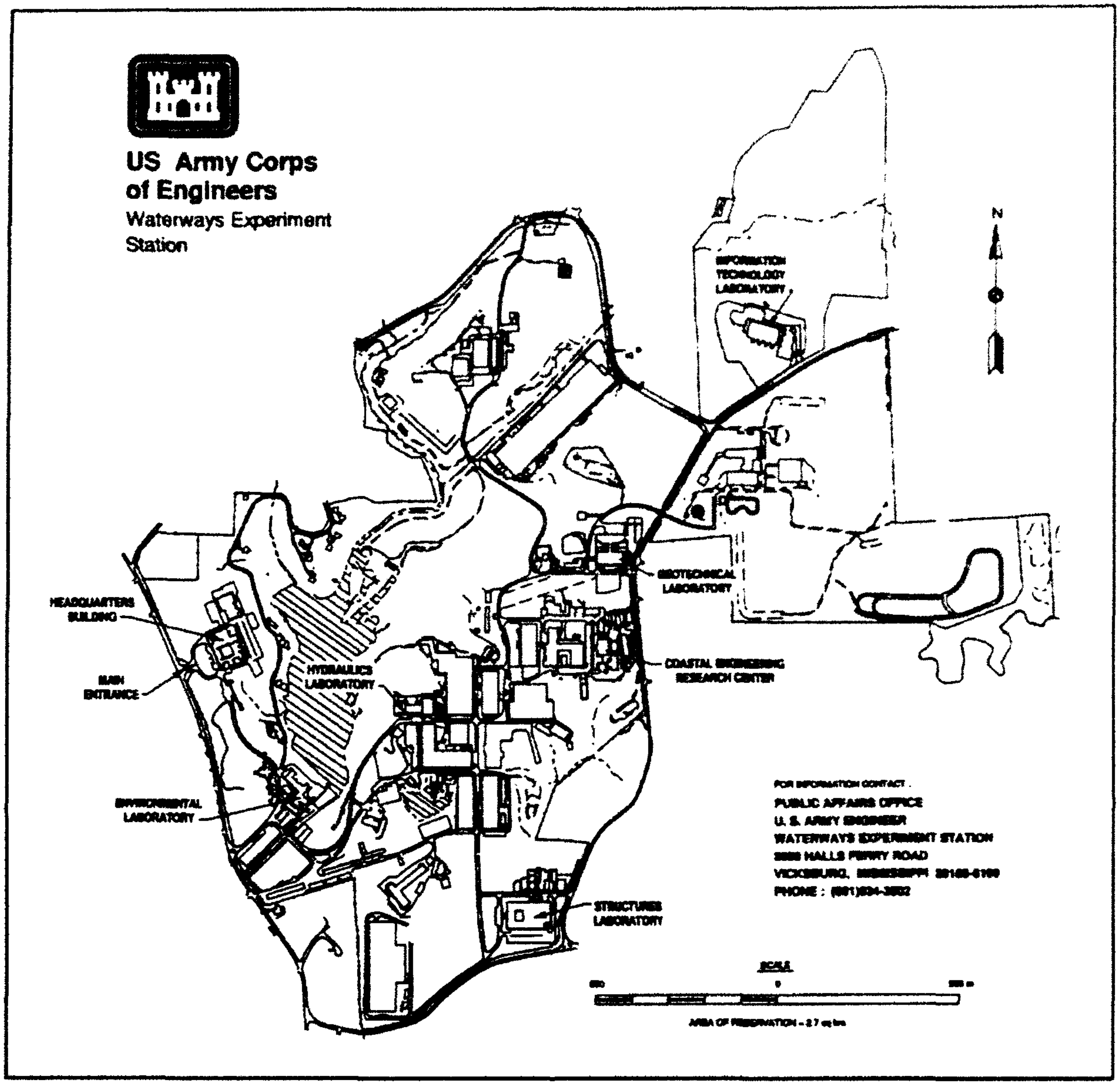

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Contents

Preface

The work reported herein was sponsored by Headquarters, U.S. Army Corps of Engineers (HQUSACE), under Department of the Army Project No. 4A762719AT40, "Obstacle Planning, Construction and Reduction," Task Area BP, "Obstacles," Functional Area, "Countermobility," Mission Area, "Military Engineering," Work Unit 002, "Tactical Hydrology." Mr. J. Lundien was the HQUSACE Technical Monitor.

The study was conducted by the U.S. Army Engineer Waterways Experiment Station (WES) under the general supervision of Mr. Frank Herrmann, Jr., Director, Hydraulics Laboratory (HL), and Mr. W. H. McAnally, Chief, Estuaries Division (HE), HL, and under the direct supervision of Mr. W. D. Martin, Chief, Engineering Branch (HB), HL. This report was prepared by Mr. Mark R. Jourdan, HB.

During preparation and publication of this report, Dr. Robert W. Whalin was Director of WES. COL Bruce K. Howard, EN, was Commander.

1 Introduction

Background

The Simplified Dam Breach Flood Forecasting Model (SMPDBK) was developed by the National Weather Service (Wetmore and Fread 1984)[1] to delineate areas endangered by dam breach floodwaters, while substantially reducing the time, data, computer facilities, and technical expertise required in employing more highly sophisticated flow routing models. SMPDBK was adopted by the Military Hydrology Team at the U.S. Army Engineer Waterways Experiment Station as the microcomputer capability for use by the Army terrain teams in predicting dam breach flooding in tactical environments. The military version of SMPDBK was subsequently called the Tactical Dam Analysis Model (TACDAM).

Designed for interactive use, TACDAM allows the user to enter as much or as little data as are available. Preprogrammed defaults are used when the response to a prompt indicates that data are not available. TACDAM provides a front-end processor which enables the user to input data using a series of screen formats. Once entered, the data can be permanently saved on a disk file for use at some future time. The program allows for easy updating of the files. All options in the program are menu driven and, therefore, user friendly. Output is to the CRT or printer in alphanumeric form.

Early versions of the model allowed input data through an interactive session of program-generated questions and user responses. At the end of the input session, the input data was lost and would have to be reentered if another run was needed. Early Apple versions were of this type.

The revised version described here allows several enhancements. The user can doublecheck the input data on each screen and, if necessary, make changes before proceeding. At the end of the input session the user can permanently save the data file, which can then be used as input for the

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[1] J. N. Wetmore and D. L. Fread. (1984). *"The NWS Simplified Dam Break Flooding Forecasting Model for desk-top and hand-held microcomputers."* Federal Emergency Management Agency. Washington, DC.

file option of the model and can be easily modified by employing the UP-DATE/CHANGE option.

The new version also permits the user to run the short version of the model, which is intended to be used when time is critical or when a complete set of input data is not available. The revised version also allows the input of metric data.

Purpose

This is a TACDAM user's manual. While general applications may be implemented with this manual, it is specifically written to assist U.S. Army terrain team members in using the model.

Scope

Version 3.2 of TACDAM is described in this manual. Descriptions of the data input, along with possible sources of data, and model output are provided. Information on model application difficulties and suggested means of overcoming the difficulties are also provided. Finally, model operation is described.

2 Model Description

TACDAM was originally written in Apple BASIC on an Apple IIe. To reduce execution time, it was then written and compiled in Microsoft FORTRAN on an Apple IIe. Finally, the program was written and compiled in Ryan-McFarland FORTRAN to execute on MS-DOS PC's; Version 3.2 of TACDAM is presented herein.

The model structure, input requirements, output, and model limitations are described below.

Menu Options

The TACDAM model main menu consists of six choices: (1) Explanation of Model, (2) Create a New File, (3) Display Directory of Files, (4) Update/Change an Existing File, (5) Run TACDAM Model, and (6) Exit to DOS.

Explanation of Model

The explanation of the model is divided into six sections. Five of the sections provide the user with a description of the model, the input required to run the model, the default values that can be used within the model, some model limitations, and an explanation of the model output. The final section allows the user to print convenient data sheets that can be used when gathering data. A copy of these input sheets can be found in Appendix A.

Create a New File

This option allows the user to input data for a new file. A description of the input data for both the short and long versions can be found in the following section.

Display Directory of Files

This option allows the user to list all data file names previously developed by TACDAM.

Update/Change an Existing File

This option allows the user to modify files that have previously been created.

Run TACDAM Model

This option processes the input data and outputs tabular results to a CRT/printer. A description of the output data can be found in Chapter 3.

Exit to DOS

This option allows the user to exit TACDAM.

Input

The TACDAM model includes both a short and a long version. The short version is to be used when time is limited. The long version should be used when more time is available to develop the proper input. The accuracy of results is improved when the long version is executed.

Within limits, the TACDAM model allows the user to enter as much or as little data as are available, automatically applying preprogrammed defaults for unavailable data. Using these internally set default values, TACDAM is capable of producing approximate flood forecasts after reading in only the dam structure type, dam height, reservoir volume or reservoir surface area, and depth-versus-width data for the cross section of the downstream valley (determined from onsite inspection or topographic maps). If, however, the user has access to additional information (i.e., the reservoir surface area, estimates of the final breach width and depth, the time required for breach formation, the turbine/spillway/overtopping flow, the slope of the channel and the Manning roughness coefficient, and the flood depth and elevation-versus-width data for up to 15 downstream channel cross sections), the model will use this information to improve the accuracy of the forecast.

Data sources

The best possible data source is the owner's records. If these records are not available, a 1:50,000-scale topographic map can be used to obtain the necessary input values. When possible, onsite inspection can be very useful, particularly for describing the downstream channel. Aerial photography is especially effective for estimating the Manning roughness coefficients.

Another excellent source of reservoir data is the Department of Defense Water Resources Data Base (WRDB) maintained by the Terrain Analysis Center, Topographic Engineering Center, Fort Belvoir, VA. This data base contains all data necessary to run the short version of TACDAM. Queries concerning this data base should be directed to Mr. Allen DeWall at 703/355-2900.

Several sources of published data are available. References for three of the better sources are:

World register of dams. (1984). International Commission of Large Dams, Paris.

N. F. Mandzhauidze and G. P. Mamradze. (1963). *The high dams of the world* (translated from Russian), Israel Program for Scientific Translations for the U.S. Department of the Interior and the National Science Foundation, Washington, DC.

World dams today '77. (1977). 4th ed., The Japan Dam Foundation, Tokyo.

The *World Register of Dams* (WRD) lists information about dams located in 132 countries. All dams 15 m or higher are supposedly included. Dams between 10 and 15 m may be included, provided they meet at least one of the following conditions:

a. Crest length 1,500 m or greater

b. Reservoir volume 1,000,000 cu m or greater

c. Maximum design discharge from the dam 2,000 cu m/sec or greater

d. Especially difficult or complex foundation problems

e. Particularly unusual design

Dams less than 10 m in height are not included in the register. The WRD offers the following data for included dams:

a. Name of the dam

b. Year of completion

c. Name of the river

d. Nearest city

e. State or province

f. Type of dam

g. Type of foundation

h. Dam height above lowest foundation

i. Length of the crest

j. Volume of the dam

k. Volume of the reservoir

l. Surface area of the reservoir

m. Purpose of the reservoir

n. Maximum discharge of the spillways

o. Type of spillways

p. Owner agency

q. Engineering firm

r. Construction firm

The High Dams of the World is a systematic arrangement of published data from 47 countries on dams higher than 75 m . All information is given in tables.

An alphabetical listing of all the dams includes the following data:

a. Name of the dam

b. Name of the river

c. Dam height

d. Type of dam

e. Year of completion

More detailed data are given in separate tables for each type of dam, such as gravity, arch-gravity, buttress, lightweight gravity, rockfill, earth, local soil, and composite dams.

Finally, a reference to sources is given for each dam, where all the examined or cited sources are indicated.

World Dams Today contains data on 138 dams in 48 countries. These dams are described in a series of articles that detail each dam, many with site plans and drawings. Most of the dams included presented unique problems in location or construction.

There may be some discrepancies when comparing data from different sources. If a discrepancy is found, it is up to the user to determine the proper source to use. An example of a possible discrepancy is a difference in the height of the dam. Dam height may be listed differently in different sources. Typically, any such discrepancies would be small and would not affect the results of the analysis. The user should examine all the data sources, including topographic maps, to determine the proper value to use. The user may then want to perform a simple sensitivity analysis, using both values, to determine if there is any appreciable difference in the results.

Data

Data requirements are different when using the short and long versions of TACDAM. However, since many of the data requirements are common, all requirements are listed below, with a brief statement explaining whether it is needed for the short version, long version, or both.

Dam type. The dam type is required for both the short version and the long version.

The dam structure type is used for the estimation of default values for final breach width, time of failure, and valley width at the bottom of the dam. The three recognized dam structure types are earth, concrete gravity, and concrete arch.

Earth dams, the slowest to breach, are embankments of rock or earth. Those that consist of earth will typically have a grass cover. Earth dams have a broad base along the axis of the stream.

A concrete gravity dam depends on its own weight for stability and is usually straight or slightly curved in plan. Like the earth dam, a concrete gravity dam will have a broad base along the stream axis.

A concrete arch dam is curved in plan and has a thinner cross section than comparable gravity dams. Arch dams transfer most of the water load horizontally to the abutments by arch action and thus can be used only in

narrow canyons where the walls are capable of withstanding the thrust produced by arch action. Typically these dams are the easiest to breach, resulting in the shortest breach time and the widest final breach.

Dam structure type can usually be determined from aerial photography or from the WRD and WRDB references. In some cases, the structural type can be determined from a 1:50,000-scale topographic map.

Some structures may incorporate more than one dam type. For example, curved dams may combine both gravity and arch action to achieve stability. Long dams often have a concrete gravity river section containing spillway and sluice gates and earth or rock-fill wing dams for the remainder of their length. In the case of dams which consist of more than one type of structural component, the dam structure type that will produce the greatest flooding downstream should be chosen. If the dam type is unknown, the user should select a concrete arch structural type. This will result in the greatest predicted peak discharge downstream to occur within the shortest time period.

Dam height. The dam height is required for both the short and long versions. However, in the long version, the user must input the dam crest elevation and the elevation at the bottom of the channel below the dam. In the short version, the dam height is entered directly.

The height of the dam is measured either in meters or in feet from the base of the dam to the water surface in the reservoir. If the water surface elevation is unknown, the dam crest elevation is used. The best source for the height is the dam owner's records. The WRD or WRDB are other good sources. If neither of these is available, the data may be obtained from a 1:50,000-scale topographic map or through photographic analyses.

Discrepancies may arise when comparing data from the WRD with topographic maps. The WRD lists the "height above the lowest foundation," which may be from the bedrock below the stream bottom. The difference between the bottoms of the stream channel and the foundation may sometimes be as great as 10 m.

Dam crest length. The dam crest length is only used in the short version. This length is used to develop the cross section downstream of the dam.

The crest length, the length along the top of the dam from one side of the valley to the other, is measured either in meters or in feet. This length is used as the width for the highest elevation describing the cross section of the dam. Required for the short version TACDAM, the crest length can be obtained from topographic maps, the WRD, the WRDB, aerial photography, or the owner agency records.

Width of bottom of dam. The width of the bottom of the dam is only used in the short version. Again, it is used to develop the downstream cross section.

The width of the channel-valley at the base of the dam is used in the short version as the width of the lowest elevation describing the cross section at the dam. Measured in meters or feet, this width can be obtained from topographic maps, aerial photography, or the owner agency records. If it is unknown, zero is entered, and a default value will be computed using the dam structure type, height, and crest length.

Reservoir surface elevation. The reservoir surface elevation is used only in the long version.

The water surface elevation is measured in meters or feet from sea level. If it is unknown, the dam crest elevation is entered. The elevation, along with that of the final breach bottom, is required to determine the head on the floodwave as it flows through the dam. The reservoir surface elevation can be determined from the owner agency records, topographic maps, or the WRDB and the WRD, which lists dam heights. To determine reservoir surface elevation using the dam height, add the elevation of the stream bottom to the height of the dam.

Reservoir surface area. The reservoir surface area is used in both the short and long versions.

Surface area can be obtained from the owner agency records, a topographic map, aerial photography, or from the WRD. The reservoir surface area is expressed either in square meters or in acres. When surface area is unknown, a zero value should be entered; reservoir surface area will then be estimated on the basis of dam height, reservoir volume, and the equation for a cone. For the program to run, values for either the reservoir surface area or reservoir volume must be input.

Reservoir volume. The reservoir volume is used in both the short and long versions.

The reservoir volume is input in cubic meters or acre-feet. The user must provide either the reservoir volume or the surface area. If volume is unknown, a zero value should be entered; an estimated volume will then be computed on the basis of the equation for a cone from values of dam height and reservoir surface area.

Three excellent sources for volume are the owner agency records, the WRDB, and the WRD. Volume can be calculated from topographic maps if those maps have contour lines indicated below the surface of the reservoir. When such is not the case, topographic maps developed before the dam was constructed can be used. To calculate reservoir volume from a map, the area contained within contours is measured to determine the surface area at each contour. Incremental storage is computed by averaging

two adjacent contour surface areas, then multiplying by the contour interval. Total volume is computed by summing all the incremental volumes.

Breach bottom elevation. The breach bottom elevation is used only in the long version.

The final breach bottom elevation is expressed in meters or in feet from sea level. If the final breach bottom elevation is unknown, the elevation of the stream bottom at the base of the dam should be entered. This and the water surface elevation are required to determine the head on the floodwave as it flows through the dam. The elevation at the base of the dam can be determined from the owner agency records or from topographic maps.

Breach width. The breach width is used in both the short and long versions.

The final breach width is measured in either meters or feet. Breach widths for earth dams are usually much smaller than associated dam crest lengths. Concrete gravity dams tend to partially breach as one or more monolith sections formed during construction of the dam are forced apart and overturned by the escaping water. Concrete arch dams tend to fail completely.

If the user does not wish to estimate final breach width, a zero value should be input; an estimated value of the final breach width will then be made on the basis of dam characteristics. The default value of breach width should be used unless real-time information is available.

Failure time. The failure time is used in both the short and long versions.

Failure time is measured in minutes. For an earth dam, failure times range from a few minutes to several hours, depending on the height of the dam, the type of materials used in construction, and the degree of compaction of materials. Failure times for concrete gravity and concrete arch structures are usually in the range of a few minutes.

When analyzing a dam breach resulting from munitions, the type of munitions must be taken into account. For conventional munitions, time of failure can be estimated as described above. However, for nonconventional munitions, failure would be almost instantaneous.

If the user wishes to employ a default value of failure time, a zero value should be entered. An estimate of failure time will then automatically be made on the basis of dam structure type and height.

Dam outflow. The dam outflow is used in both the short and long versions.

Dam outflow is an optional entry expressed in cubic meters per second or cubic feet per second. Outflow from the dam is the combined flow in the downstream channel from water passing through the turbines, over the spillway, and over the top of the dam just before the breach process begins.

Included in the WRD are values for "discharge capacity of the spillway," i.e., the maximum flow the spillway or conduits can carry. This value would be appropriate to use when doing a "worst case" analysis.

If a dam is overtopped, as may occur during an extreme rainfall event, overtopping flow can be computed using the following broad-crested weir equation:

$$Q = 3.5LH^{3/2}$$

where:

Q = overtopping flow

L = crest length of the overtopped section

H = average overtopping depth

Units for overtopping flow will be compatible with those for crest length and overtopping depth. If an overtopping flow from the above equation is entered, TACDAM will give reasonable answers for peak depth, time to peak depth, and time to flood. However, the time to deflood (the time for the floodwave to fall back within the banks) will be completely erroneous because the program does not provide for a cessation of dam outflow.

If dam outflow is unknown and cannot be estimated, a value of zero should be entered.

Channel slope. The channel slope is used only in the short version.

The channel slope is measured in meters per meter or feet per foot, which are equivalent dimensionless numbers. Channel slope can easily be determined from a topographic map. Between adjacent contours, the slope is equal to the contour interval divided by the associated channel distance. For TACDAM applications, it is generally advisable to use the average channel slope from the dam to the critical section (principal forecast point) downstream. The average slope is computed by dividing the elevation difference by the associated channel distance.

If the channel slope is unknown and cannot be determined, a zero value should be entered. A default value will then be computed internally on the basis of reservoir characteristics.

Channel reach length. The channel reach length is used only in the short version.

Channel reach length is expressed in kilometers or miles. For a given cross section it is the total associated distance to the dam, not to the next upstream cross section. For the short version of TACDAM, channel reach length is measured from the critical section to the dam.

Cross sections. Cross sections are required for both the short and long versions.

For the long version of TACDAM, data from 3 to 15 cross sections may be entered. Cross section data define the channel and valley geometry between the dam and the principal forecast point. Data are paired; for a particular elevation, an associated top width distance that corresponds to the width of the channel or valley at that elevation is input. When developing cross sections for TACDAM, the direction in which the width is measured (relative to facing downstream) does not change the results.

For the long version, the first cross section should be located at the base of the dam, and the second should be a short distance downstream. This pair of sections is required for the calculation of conveyance immediately downstream of the dam, taking into account the possible effects of submergence on the floodwave flowing through the breach. The third required cross section is used to define the channel and valley geometry at the principal forecast point. The remaining cross sections are used to define geometries of the intermediate reaches.

For the short version of TACDAM, the cross sections used are not input but are based on dam and reservoir characteristics.

Cross sections chosen should not be atypical, i.e., representative of controlling or constrictive channel geometries or inordinately broad and open geometries (see Limitations). In certain cases, it may be necessary to develop cross sections that represent an average or typical channel and valley geometry rather than a specific site geometry.

Lowest channel elevation. The lowest channel elevation at a particular cross section is expressed in either meters or feet above sea level. For the first cross section, this should be the elevation at the base of the dam.

Width. The width, expressed in either meters or feet, is the active flow portion of a cross section corresponding to each elevation. Figure 1 illustrates the width of a channel.

Inactive width. The inactive width is the width of the off-channel storage portion of the channel-valley cross section corresponding to each elevation. Figure 2 illustrates active and inactive width.

Inactive width is expressed in either meters or feet. Off-channel storage occurs where the flow velocity is considered negligible relative to the velocity in the active area of the cross section. Such dead or off- channel storage areas can be used to effectively account for embayments, ravines,

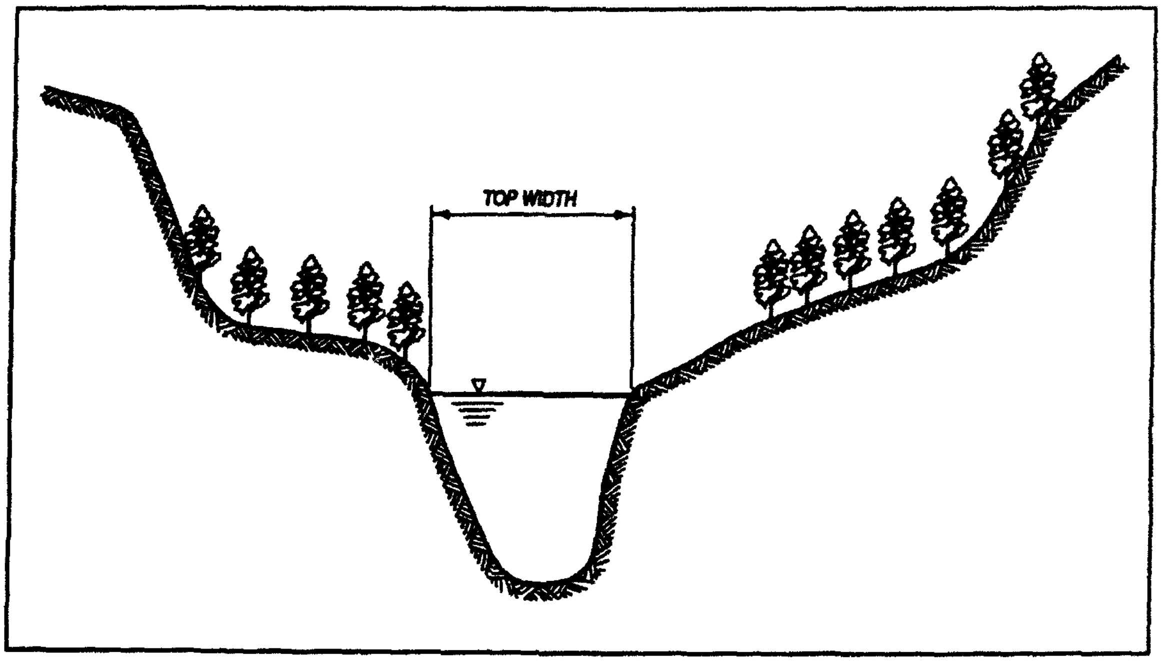

Figure 1. Channel width

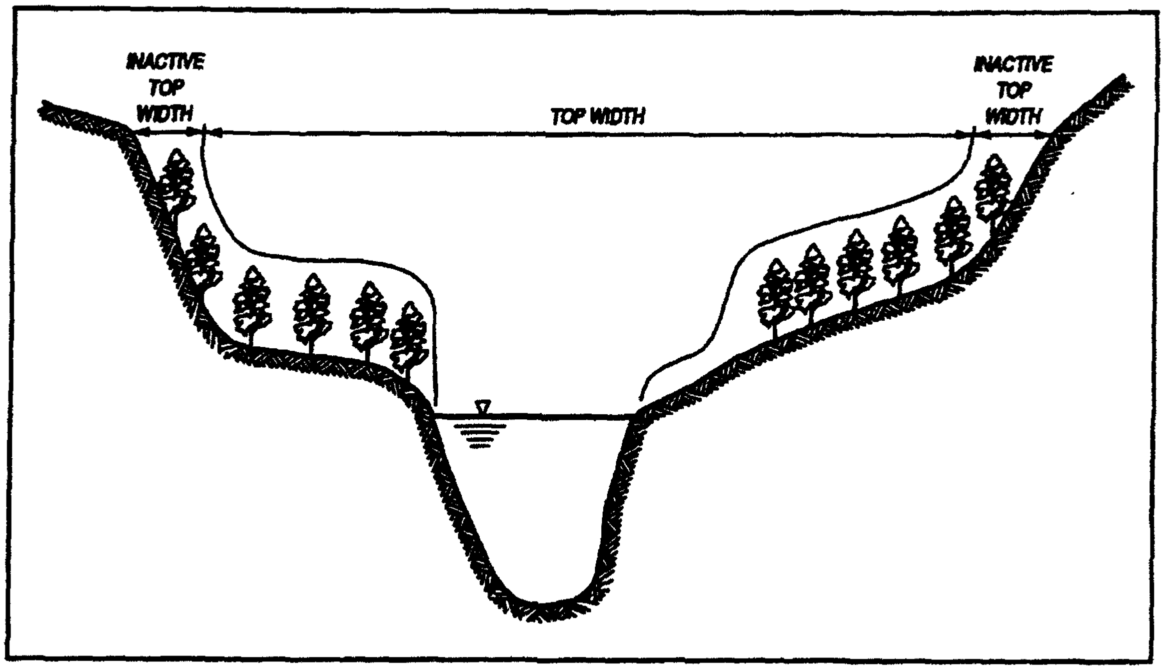

Figure 2. Channel width and inactive width

or tributaries which connect to the flow but are inactive in the sense that they serve only to store the flow. Another effective use of inactive width is for modeling a heavily wooded flood plain which stores a portion of the flood waters passing through the channel.

Manning's n. Manning's n values are required for both the short and long versions.

Manning's n is a measure of roughness, a factor which influences flow velocities. Manning's n values are entered with the cross section data; specifically, an n value is entered in association with each elevation value. An n value entered at one elevation impacts on computations for flows that occur between that elevation and the next higher cross section elevation.

If large-scale photography is available or onsite inspection is possible, the following guidelines can be followed.

Channel Condition	n value
Clean, straight, full stage, no pools	0.029
As above, with weeds and stones	0.035
Winding, pools and shallows, clean	0.039
Winding, pools and shallows, weeds, stones	0.042

For overbank flow, the following can be used:

Overbank Condition	n value
Pastureland	0.04
Moderately wooded	0.07
Heavily wooded	0.10-0.15

In the long version, if a zero value is entered in association with the first elevation of a cross section, default Manning's n values of 0.05 will automatically be assigned for the entire section. If a zero value is entered in association with any elevation other than the lowest channel elevation, that and subsequent n values will be the same as the previous n value.

In the short version, an average value of Manning's n is input for the total reach.

Flood depth. Flood depth is only required in the long version.

The flood depth is measured in meters or feet from the lowest channel elevation. It is that depth at which flooding becomes a recognized problem, e.g., the depth at which flooding would hinder mobility. The flood depth is used in determining the time of flooding and deflooding.

Options

As previously noted, there are short and long versions of TACDAM. For the short version, five types of data are required: (1) dam structure type, (2) dam height, (3) dam crest length, (4) reservoir volume or reservoir surface area, and (5) channel reach length. All other types of input are optional and have associated default values which may be invoked. However, channel slope should be measured and input except in extreme cases where time is a limiting factor.

For the long version of TACDAM, required input includes the following: (1) dam structure type, (2) dam crest elevation, (3) breach bottom elevation, (4) reservoir volume or reservoir surface area, (5) number of cross sections, and (6) number of elevation-width pairs. In addition, cross-section information, which includes the distance downstream from the dam and elevation-width pairs must be input. All other types of input are optional and have default values which may be invoked.

Default values

Default values are automatically generated by TACDAM when data are not available. Such values are indicated with an asterisk in the input listing. The default values used in TACDAM are described below.

Default values for failure time are determined on the basis of dam structure type and dam height. A breach erosion rate of 15.2 m/min (50 ft/min) is used for concrete arch dams; thus default values for failure time are just a few minutes long. On the other hand, the assumed breach erosion rate for earth dams is generally about 1 m/min (3 ft/min), and the default values for failure time are much longer than for concrete arch dams.

The final breach width will default to three times the height for earth dams and five times the height for concrete gravity dams. For concrete arch dams, the final breach width will default to 0.9 times the crest length when the short version is used. For the long version of TACDAM, the final breach width will generally default to 0.9 times the sum of the active and inactive widths for the highest elevation input at the dam. An exception occurs, however, when the second cross section is relatively narrow; in this case the breach width will default to 1.2 times the sum of the active and inactive widths for the second elevation-width pair.

The width of the valley bottom at the dam, used only in the short version, will default to the crest length minus two times the height times the side slope of the dam. The side slope used is 1.733 for earth dams and 0.577 for concrete dams.

For the program to run, values for either the reservoir surface area or reservoir volume must be entered. The reservoir surface area will default to three times the reservoir volume divided by the dam height if volume is input. The reservoir volume defaults to the height of the dam times the surface area divided by three if area is input.

When only one cross section is given and the channel slope is not input, a default value of slope is computed using the height of the dam, the uppermost width of the cross section, and the volume of the reservoir at full pool.

In the short version, five cross sections are used. The first is at the dam and has an assumed bottom elevation of 10,000 m (32,810 ft). The top width for the bottom elevation-top width pairs is the width of the valley at the dam. The elevation of the top pair is the bottom elevation plus the height of the dam, with the top width for this elevation being the crest length. The elevations for the cross sections below the dam are computed based upon the elevation at the dam and the channel slope. Top widths remain constant.

The flood depth defaults to 3.0 m (10 ft).

Output

TACDAM output includes peak flow, peak depth, time to peak flow, and time of flooding and deflooding for specified stations downstream of the dam.

The peak flow, output in cubic feet per second or cubic meters per second, is the maximum flow at a specific cross section. The peak depth, output in feet or meters, is the peak depth at that cross section. The time to peak depth, output in hours, is the time after the initiation of the breach that the floodwave peaks at that cross section. The time of flooding and deflooding is output in hours to indicate the time at which the floodwave will go above a recognized problem depth and the time at which the flood will recede below that depth.

The output should be examined for possible errors. One key to possible problems is an increase in depth with distance downstream. When this occurs, the first check to make is channel slope; if slope drastically decreases, a higher stage could be possible. Another possible explanation is the mistaken selection of controlling or constrictive cross sections. Since TACDAM uses a sequential routing procedure, it does not account for

backwater which may be caused by a downstream controlling section. In this case, the cross sections must be modified to represent an average or typical rather than an anomalous cross section.

A flooded area overlay may be developed using the peak depth from the output table. Each cross section should be identified on the overlay with maximum depth plotted at those locations. The area flooded between cross sections is determined by interpolation.

Limitations

Comparisons have been made of several dam-breach flood routing models with observations from some actual dam-breach floods. These comparisons indicate that even the most advanced models are limited in terms of accuracy. Errors on predicted flood crest profiles are usually plus or minus 0.3-0.6 m (1-2 ft) or more for all of the models, even when the actual breach geometry is specified as input to the model. Several factors cause errors in the prediction accuracy of the most advanced dam breach models. Some of these are described below, along with techniques to improve accuracy. Proper simulation often requires an iterative solution procedure.

Dam breach

Calculation of the peak outflow at the dam requires dam, reservoir, and breach characteristics. Dam and reservoir factors required include dam height, reservoir volume, and surface area. An error in dam height can have significant effect on the peak depth, while an error in reservoir surface area or volume will affect the attenuation of the flood wave, or the time the flood wave sustains itself and remains at a high level.

A large breach width and small time to breach produces maximum flooding, while a small breach width and large time to breach produces minimum flooding. Time permitting, sensitivity analyses should be performed on these parameters to determine the importance of each. A matrix can be developed using the different types of input as variables and determining the peak discharge and time to peak for various cases.

Downstream geometry

Calculating the peak flow and time to peak at specified cross sections downstream of the dam requires cross-section geometry and roughness coefficients. Cross-section errors can affect both the size and attenuation of the peak flow.

The dam-breach peak discharge may be modified by submergence conditions caused by the downstream channel. Submergence occurs when the computed depth in the downstream channel is great enough to affect the outflow from the breach. When submergence occurs, a correction to the peak flow is made using an interactive procedure. This submergence correction can cause a significant effect on the breach peak discharge.

The submergence condition is a function of the channel geometry immediately downstream of the dam. Because the submergence can have an extreme effect on the calculated peak discharge, channel geometry specifications downstream of the dam become all-important.

Channel routing is performed using a sequential procedure which does not account for downstream channel control. Ideally, relatively wide and/or constrictive cross sections should be chosen to demonstrate the transitional nature of the channel. However, the choice at these locations may result in an oscillating water surface profile, because TACDAM uses a sequential routing procedure which has no knowledge of backwater that may be caused by a downstream controlling section. Thus, the possibility exists that an upstream stage that is less than a downstream stage may be predicted.

3 Model Operation

If a dam break is imminent, as much information as possible should be obtained and recorded on input sheet No. 1, presented in the Appendix. Suggestions pertaining to the operation of the short and long versions of TACDAM are presented below.

Short Version

If only a few minutes are available to conduct a dam breach analysis, the short version of TACDAM should be used. First, the dam should be located on the topographic map. The average slope for the reach of concern, i.e., from the dam face down to the point of interest, should be determined. If the crest length or width of the valley at the base of the dam are unknown they should be measured on the topographic sheet. These values are required to define the dam cross section.

If neither the reservoir surface area nor the volume is known, the surface area of the reservoir should be measured on the topographic map and converted to either acres or square kilometers. This information should be recorded on input sheet No. 1 and the short version of TACDAM run. Prompts for the various types of input will appear on the screen. Input sheet No. 1 can be checked for short option minimum input requirements. Values for other variables may be defaulted by entering zero values.

The output from the short version of TACDAM will be reasonable, accuracy being limited primarily by the lack of downstream cross-section geometry.

Long Version

If time and information permit, the long version of TACDAM should be used. Topographic maps should be closely examined, elevations for the top and the bottom of the dam should be determined, and the river

reaches downstream from the dam, particularly at pertinent forecast points and/or points which represent changing cross sections, should be closely scrutinized.

Input sheet No. 2 (included in Appendix A) should be used to define selected cross sections in terms of channel bottom elevation and elevation-width pairs. Unless the user is very quick and/or has plenty of time, the number of elevation-width pairs should be limited to 3 or 4 at most. Each cross section defined must contain the same number of pairs.

Input sheet No. 1 should be checked for minimum input. Just as in the short version, default values for unavailable data may be used.

The long version will generate a forecast that has a reasonably high degree of confidence associated with it because important geometric definition of the channel reaches downstream from the dam has been included.

Appendix A
TACDAM Input Sheets

TACDAM Input Sheet No. 1

	Short Version[1]	Long Version[2]
1. Name of dam		
2. Name of river		
3. Dam type: Earth Concrete gravity Concrete arch		
4. Dam height (ft or m)		
5. Dam crest length (ft or m)		
6. Width of bottom of dam (ft or m)		
7. Dam crest elevation (ft or m msl)		
8. Breach bottom elevation (ft or m msl)		
9. Breach width (ft or m)		
10. Reservoir volume (acre-ft or cu m)		
11. Reservoir surface area (acres or sq m)		
12. Time to failure (min)		
13. Turbine/spillway/overtop flow (cfs or cms)		
14. Average channel slope (ft/ft or m/m)		
15. Average Manning's n		
16. Distance downstream to forecast point (miles or km)		
17. Number of elevation width pairs		
18. Number of cross sections		

[1]For minimum input to run short version, values for 1, 2, 3, 4, 5, 10 or 11, and 16 must be entered. All other parameters have default values which may be invoked.
[2]For minimum input to run long version, values for 1, 2, 3, 7, 8, 10 or 11, 17, and 18 must be entered, plus all input required on input sheet No. 2. All other input parameters on this sheet have default values which may be invoked.

TACDAM (Long Version) Input Sheet No. 2

Cross section				
Distance downstream from dam (miles or km)				
Flood stage - height above channel (ft or m)				
	Elevation (ft or m msl)	Width (ft or m)	Inactive Width (ft or m)	Manning's n
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

Cross section				
Distance downstream from dam (miles or km)				
Flood stage - height above channel (ft or m)				
	Elevation (ft or m msl)	Width (ft or m)	Inactive Width (ft or m)	Manning's n
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

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This report is a user's manual for the Tactical Dam Break Model (TACDAM). TACDAM is a model that was developed to assist U.S. Army terrain team members in predicting downstream effects of a dam break. Descriptions of the data input, along with possible sources of data, are provided. Information on model application difficulties, along with suggested means of overcoming the difficulties, are provided. Finally, model operation is described.

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